UCRL-JC-125185 Abs

Sensitivity of Simulated Salinity in a Three-dimensional Ocean Model to Sinking of Salt From Sea Ice Formation*

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Salinities simulated with three-dimensional ocean models are typically unrealistic in two important respects: (1) deep ocean salinities are too low; (2) the intermediate-depth salinity minimum due to Antarctic Intermediate Water is absent or weak. We show that both these problems can be largely eliminated by forcing the salt released by sea-ice formation to sink to depths of up to 160 m. That is, when sea ice forms, we distribute the rejected salt uniformly between the surface and 160 m depth. The fact that this produces much improved simulated salinities demonstrates the sensitivity of a global ocean model to the transport of salt in the upper ocean in regions where sea ice forms. The rationale for sinking ice-related salt are (1) salty water is dense, and therefore tends to sink; (2) in the real ocean, sinking of water containing salt rejected during sea ice formation probably occurs on horizontal scales much smaller than a typical GCM grid cell; thus this sinking is probably not well represented by the typical parameterizations of convection used in OGCMs. While the concept of sinking ice-related salt is physically motivated, the specific approach we use to do so is not; rather, our results are intended to show that simulated salinities are very sensitive to the transport of salt in the upper 160 m of the ocean, near regions of sea ice formation. This suggests that the same may be true in the real ocean. Our results also suggest that simulated salinities in three-dimensional ocean models could be dramatically improved by a good parameterization of small-scale convection. In addition to dramatically improving simulated salinities, the sinking of ice-related salt significantly increases (and makes more realistic) the strength of the simulated Antarctic Circumpolar Current.

*This work was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.

1. 1996 Fall Meeting

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5. a) OS 06 Global Ocean Modeling
b) 4572 upper ocean processes
4532 general circulation
4568 turbulence, diffusion, and mixing processes
4215 climate and inter-annual variability
4255 numerical modeling
c)

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8. 0%

9. Attached PO#

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12. Yes, Oceans Sciences Section

13. No